Path Forward for Coronagraph Design

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1. Timeline

2. Remaining Paths for Improvement

3. Merit Functions
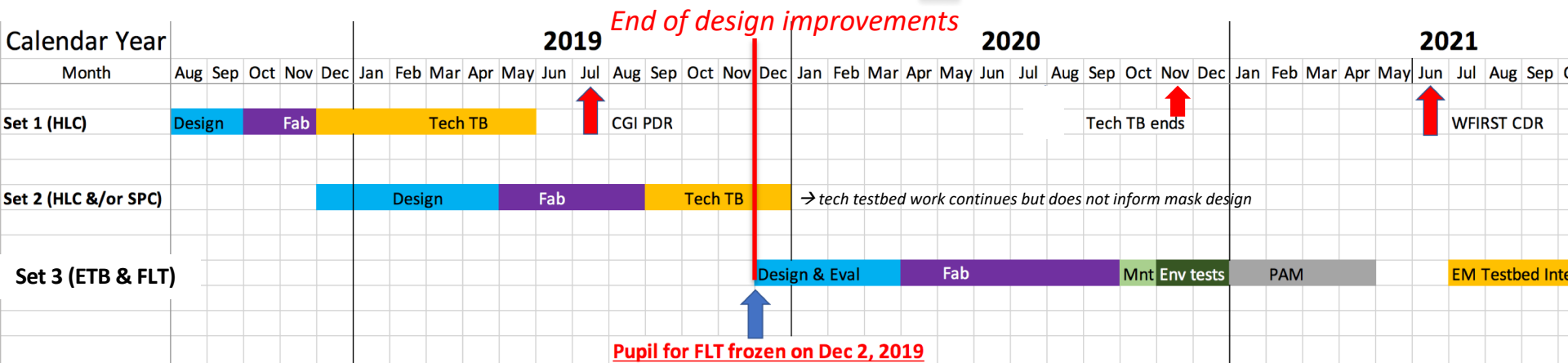
3 Mask Design Cycles Remaining

1. Test new fab method of HLC masks
2. Test new mask features or combos
3. Final Masks: for ETB and FLT

Last chance for big changes requiring HCIT verification

- **13 months left total** for all improvements to CGI coronagraph design process
  - Engineering Testbed (ETB) required to have same exact mask designs as FLT.
  - ETB masks needed for mounting & testing months before ETB is built.
- **6 months left to get new mask features or combos** (for Set 2)
  - Time includes designing **and modeling**.
  - After 6 months, wouldn't get testbed results in time to inform ETB+FLT designs
- **13 months left to improve design SW and algorithms** (before Set 3)
  - Frozen coronagraph modes and mask fabrication methods

Coronagraph Components *(OMC Elements)***:**

- 2 DMs
- Shaped pupil (SP)
- Focal plane mask (FPM)
- Lyot stop (LS)

3 Coronagraph Modes:

- Spectroscopy
- Imager (<u>small</u> IWA & OWA)
- Imager (<u>large</u> IWA & OWA)

HLC

SPC

2014-2017
Configuration:

HLC:
- 2 DMs
- ~~Shaped pupil (SP)~~
- Hybrid FPM
- LS

SPC:
- ~~2 DMs~~
- Shaped pupil (SP)
- Amplitude-only FPM
- LS

Current
Investigations:

- **Offload work from DMs to FPM**
  - Extended dielectric
  - Multi-layer nickel

- **Offload work from SP to DMs**
  - For higher throughput & 360-deg FOV

Top Design Priority: Improve spectrograph performance
- SPC is baselined
  - Limited improvement possible; design process is fairly mature.
- ➢ Possibilities for much higher performance
  - ➢ **Switch to HLC** (increase to >=15% bandwidth)
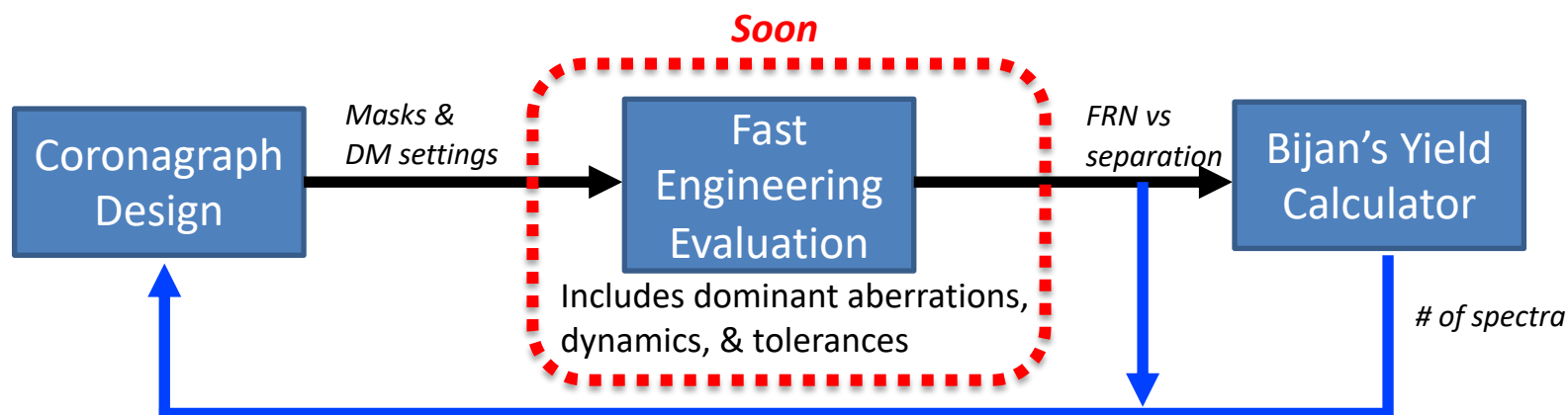 - ➢ **Hybridize SPC**

Team Members

Team Member	Institution	Roles in FY19
A.J. Riggs	JPL	Schedule, budget, hybrid design R&D, software development, SPC design
Dwight Moody	JPL	HLC R&D
Jessica Gersh-Range	Princeton	SPC trade studies, hybrid design R&D
Jorge Llop-Sayson	Caltech	HLC trade studies, hybrid design R&D
Erkin Sidick	JPL	Design algorithms, LOWFS modeling
Navtej Saini	JPL	Software development

Main tasks this fiscal year:

1. Hybrid design R&D
2. Software development
   - Adding features, speedups, & cluster compatibility

- **Top Design Priority: Improve coronagraph for IFS**
  - [*Engineering merit function*]: **flux ratio noise (FRN)** @ 4 λ/D.
  - [*Science merit function*]: **# of possible RV planet spectra**.
  - How much do these overlap? Relevant separations seem to differ.

- **Main Hurdle**:
  - Most remaining performance gains will be from trading something for something else.
  - Designers need a *fast* **merit function calculator** to see if we made performance better or not.
    - Goal is to make this calculator in 1-2 months

- **Narrow Field of View (NFOV) Imager**
  - [*Engineering merit function*]: **flux ratio noise (FRN)** @ 4 λ/D.
  - [*Science merit function*]: **# of imaged RV planets**.

- **Wide Field of View (WFOV) Imager**
  - [*Engineering merit function*]: **Point-source sensitivity**
  - [*Science merit function*]: **TBD**
  - ➢ **More clarity needed**

- **We need feedback to optimize designs**
  - No merit function --> no optimization
  - No merit function calculator → no optimization

- Extended source (i.e., disk) imaging
  - **Action item for SITs**: merit function needed

- Spectroscopy and imaging of point sources
  - Merit functions somewhat established
  - **Action item for SITs**: agreement on scientific merit functions
  - Action item for JPL: fast engineering performance calculator needed